1924

British 219,150

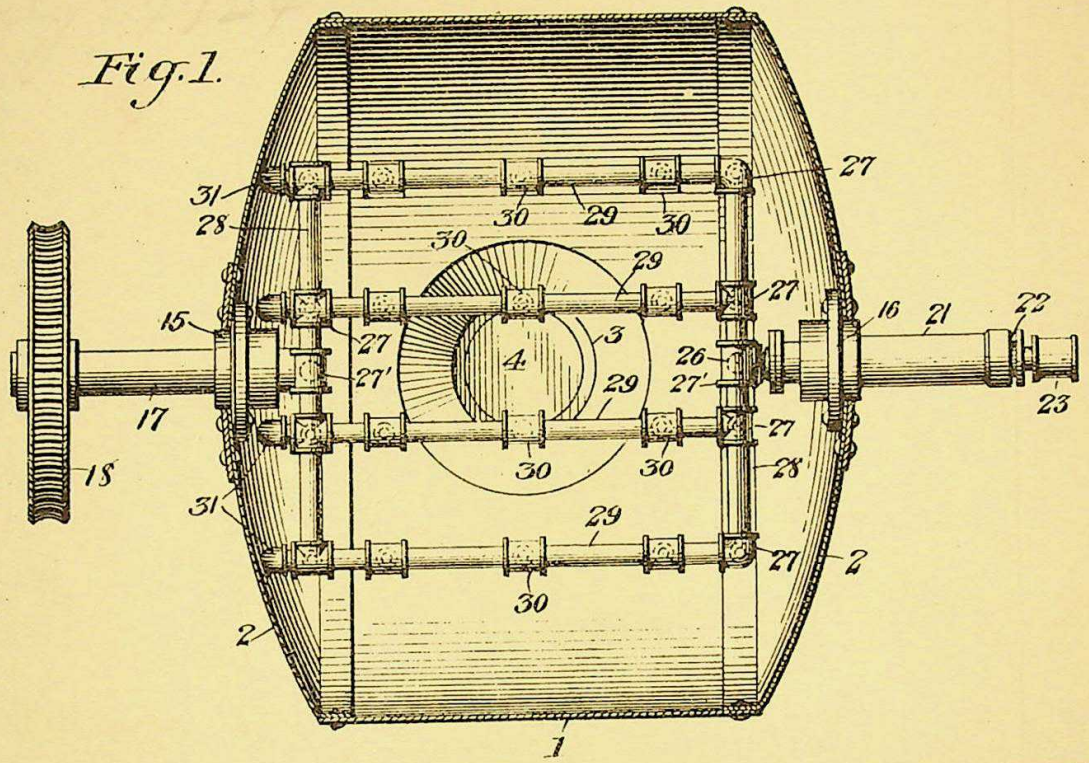
219,150 COMPLETE SPECIFICATION

259/168

[This Drawing is a reproduction of the Original on a reduced scale]

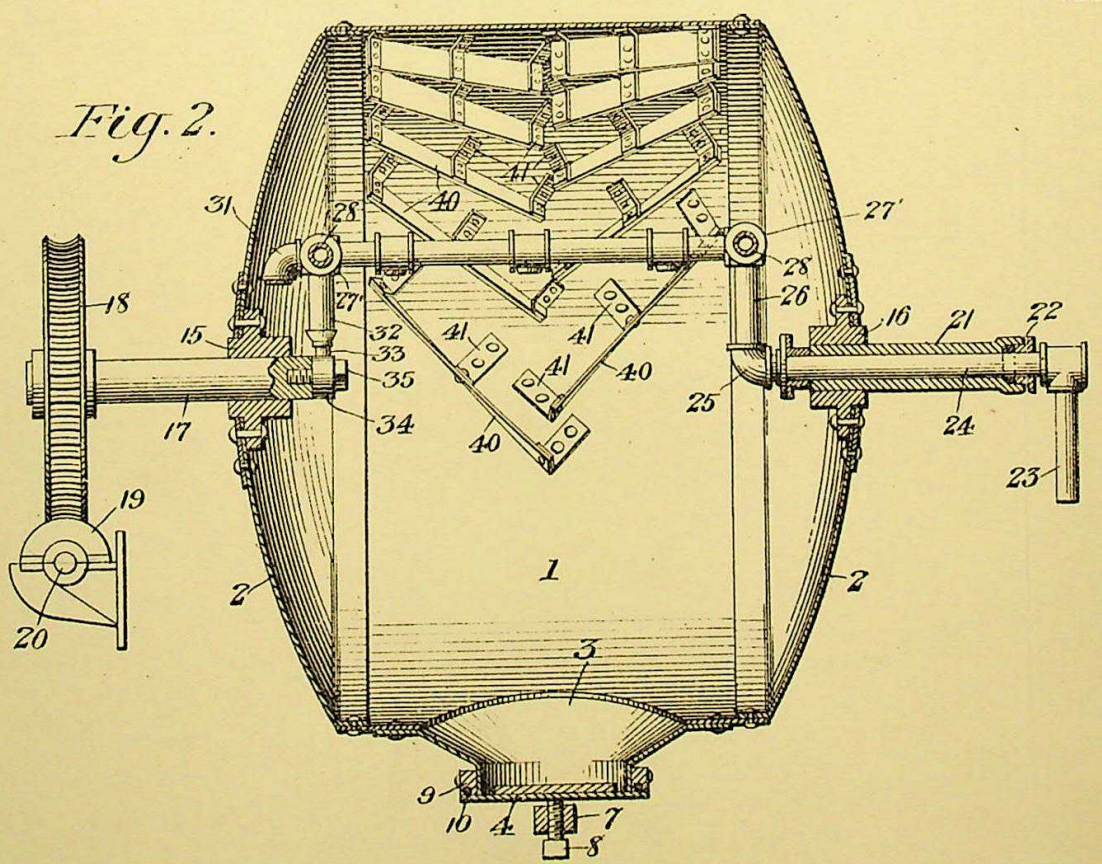
SHEET 1

Fig. 1.



SHEET 2

Fig. 2.



219,150 — 1924

3 SHEETS
SHEET 3

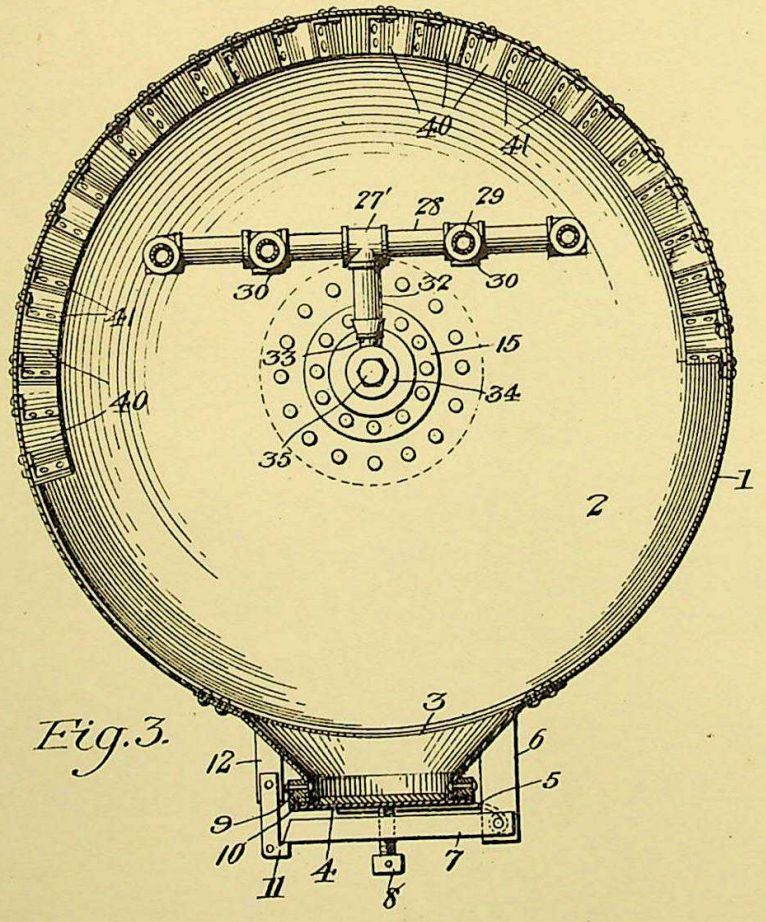


Fig. 3.

Malby & Sons, Photo-Litho

PATENT SPECIFICATION

Application Date: June 26, 1923. No. 16,549/23. **219,150**

Complete Accepted: July 24, 1924.

COMPLETE SPECIFICATION.

Improvements in and relating to Bituminous Cement-aggregate Composition.

I, SAM EVERETT FINLEY, of 210, West North Avenue, in the City of Atlanta, County of Fulton, State of Georgia, United States of America, a citizen of the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to a novel form of bituminous cement-aggregate composition for surfacing walks, roadways, streets, roofs, floors and the like, and to a method of and apparatus for preparing the same, and has for its purpose to effect a mixture of aggregates such as stone, pebbles, gravel, slag, shell, sand, clay dust, or other inert material, either singly or in combination, with bituminous cementitious or binding media, in suitable proportions, in such manner as to ensure a uniform distribution of the various sized elements of the aggregate throughout the mass, and a thorough surface coating and corporeal impregnation or penetration of the individual elements of the aggregate with the bituminous material; whereby the uniformly distributed aggregate will be firmly and uniformly bonded in the fabricated surface layer or coating, and the individual elements of the aggregate will be materially strengthened and reinforced by the impregnating binder, so that a highly durable, wear resisting moisture and weather proof surface will result when the composition is applied to its intended use.

To these ends the invention resides in a method of preparing a bituminous cement-aggregate composition which comprises distributing the various sizes of aggregate uniformly throughout the mass by agitation and applying a predetermined proportion of binding medium to the mass, while the latter is in an agitated condition, in the form of a uniform spray. It is preferred to heat the aggregate, prior to agitation, to an extent sufficient to drive off the moisture and open the pores of the various sizes, and after agitation and spraying of the binding medium, to subject the mass of aggregate and binding medium to gaseous pressure, whereby all the individual elements of the aggregate are impregnated with the binder. The apparatus for performing the method comprises a rotary receptacle having angularly disposed blades provided on a portion of its interior wall, in which receptacle the aggregate is agitated and tumbled to distribute uniformly its various sizes, and a spray header disposed inside the receptacle and having a pipe connection through the axis of rotation thereof, so as to deliver a uniform spray of binding material to the cascading and agitating aggregate, said header being adapted subsequently to admit gaseous pressure to the receptacle. The product is a cement-aggregate composition comprising an admixture of aggregate and bituminous binding medium, the individual elements of the aggregate being coated with the binding medium and the variously sized elements of the aggregate being uniformly distributed throughout the mass and united by the enveloping binding medium.

A simple, effective form of apparatus for carrying out the method is illustrated in the accompanying drawings, in which,

Fig. 1 is a sectional plan;

Fig. 2 is a sectional longitudinal elevation;

Fig. 3 is a sectional end elevation.

In the preparation and application of bituminous cement-aggregate mixtures,

comprising aggregate of various types and varying sizes associated with asphalt or similar bituminous binding media for use in surfacing roadways, walks, and the like, it has been customary to select carefully the aggregate, such as broken stone, sand and gravel, for the purpose of utilizing only the tougher, wear resisting and thoroughly cleansed elements, varying from relatively large pieces of stone or gravel down to the finest sharp sand, adding thereto in liquid form the bituminous binding medium in heated condition, and then mechanically manipulating the mass in an endeavour to obtain an intimate admixture of the aggregate and binding medium. It has been the usual practice to effect such admixture in pug-mills. It has also been proposed heretofore to charge a receptacle adapted to be rocked or revolved with a quantity of granular aggregate such as furnace slag, to heat the same in the receptacle while a vacuum is maintained therein to dry the particles and open their pores, and then, while the receptacle is stationary, to force thereinto; without destroying the vacuum, enough hot tar to submerge the charge of aggregate. The vacuum is then destroyed to drive the tar into the expanded pores of the solid particles, whereafter the surplus tar is drained off. According to other prior proposals, the binder has been sprayed in determined proportion onto the aggregate while the latter was being agitated, the relative proportions of aggregate and binder being supplied simultaneously to the drum. However, these and other methods heretofore proposed have not produced a composition in which variously sized elements of aggregate are uniformly distributed throughout the mass, and individually coated with the binder. It is thought that the reason for the failure of prior methods to produce such a composition is due to the fact that the mixing operation and the manner of supplying the liquid binder as heretofore proposed, result in the superficial coating of only the coarser materials, while the finer elements of the aggregate will roll up or collect in balls, with the result that the individual particles are not completely coated, and an effective union of the entire mass of aggregate with the bituminous binder cannot be obtained, and the resulting composition is weakened in proportion to the extent of the uncoated surfaces of the aggregate, and also to the extent of the loosely adherent masses or balls of the finer material of the aggregate distributed irregularly throughout the mixture. In other words, under the prevailing modes of preparing such mixtures or compositions, it is practically impossible to obtain a uniform distribution of the various sizes of the aggregate, or even a complete superficial coating of all of the elements of the aggregate with the binding medium, and it therefore follows that the mixture when applied to its intended use is lacking in a satisfactory mechanical bond which would be effected by a uniform distribution of the various sizes of the aggregate, and is also materially deficient in the binding effect which would be produced by even a thorough superficial coating of all of the elements of the aggregate with the binding medium.

If the aggregate contains clay or earthy material, the difficulty aforesaid is aggravated, in that the clay or other foreign material will adhere to the surfaces of the aggregate, and prevent access of the binding medium thereto. Again, it has been found that if washed gravel, that is to say, gravel which has been freed from clay and other earthy materials, is employed as the aggregate, either alone or in admixture with sand, the surfaces are either too smooth to admit of a proper union with the bituminous cement, or are so irregular that in the mechanical mixing operation all of the surfaces or faces will not receive the coating of the binding medium. If the gravel or other aggregate contained a percentage of clay or soil, it was also found to be impossible to obtain a perfect admixture, and an intimate coating with a stable bituminous binder, as employed, for the reason that it is always essential, regardless of what type of pavement or kind of aggregate is contemplated, that the aggregate be heated to a temperature of from 250° to 400° F., and at either of these temperatures, the natural tendency of the clay or soil is to bake or harden on the aggregate, so that the subsequent application of the binding medium would effect only a coating of the superficial layer of clay or soil, and would not, by any possibility, reach the underlying surface of the coarser aggregate. It has also been found, when relatively finely divided aggregate, such as sand and clay in powdered form, has been employed as a part of the component aggregate, that in the process of preliminarily drying these elements, it is practically impossible to separate completely the elements, but the latter are discharged from the dryer containing many small balls or adherent masses of the individual particles, which have not sufficient inherent strength to resist the stresses of traffic, and, inasmuch as they

can only be superficially coated with the binding medium, they will quickly break down and disintegrate when applied as a component part of the roadway structure.

It has been the common practice in preparing many bitumen-aggregate compositions, in which varying sizes of broken stone, gravel, slag, and varying grades of sand, are employed, to require a certain amount of finely divided material in powdered form, and, in some cases, pulverized clay, on the theory that these finely divided elements will be distributed throughout the mass of the aggregate and effect a mechanical bond between the larger elements of the aggregate, but however effective this may appear in theory, it has been impossible of practical realization because of the tendency of the fine matter to bake or harden under the influence of heat in the drying operation, or " set up " in contact with moisture, thereby preventing a complete superficial coating of all of the particles with bituminous binder. These unbonded masses of fine material also absorb moisture when applied to the road surface, with a resultant quick disintegration of the surface wherever these uncoated and practically unbonded masses of fine material occur.

According to the present method, no matter how clean or hard the aggregate may be, and no matter what the condition of the clay, dust, sand, or other fine material, all the foregoing objections are successfully overcome for the reason that the bituminous binding medium, under the conditions of application, is driven into and through the finely divided matter to effect a thorough mixture, intimate contact and coating of every particle, from the finest to the coarsest, and is also caused to penetrate below the surfaces and into the bodies of the coarser aggregate particles, and completely to envelop the latter, so that all the solid material is not only completely superficially coated, but is actually impregnated with the binding medium, and an intimate bonding of the solid elements thereby effected, when the aggregate is applied to the road surface. For example, with the hardest types of flint gravel and a highly stable asphaltic cement of from 40 to 45 penetration, it has been found that the binding medium has been caused to penetrate or impregnate the elements of the gravel to as great a depth as three-eighths of an inch, and also to coat completely superficially each and every element of the gravel.

It is also highly important that only the proper proportions of aggregate, with or without the fine filling material, and bituminous binding medium, be employed, and that a uniform distribution of the aggregate and the binding medium be effected, if the best results are to be obtained. The preferred percentage of bituminous cement for any given mixture is approximately 10%, and any material increase over this percentage will cause the pavement, under the impact of traffic and the effect of heat, to shove or roll, while a materially smaller percentage will cause that portion of the mass in which the deficit occurs to break up under the impact of traffic and to crack and slough off under low temperatures.

The practice of the present invention renders it possible, for the first time, to obtain uniformity of distribution of the various sizes of the mineral aggregate, and a thorough bonding of the latter, not only by reason of the complete superficial coating of every element of the aggregate, but also the penetration of the larger elements by the binding medium, which not only materially adds to the strength of the composite mass and decreases the tendency to disintegration thereof, but permits the use of various materials, which because of their structural weakness could not be utilized in bituminous cement-aggregate compositions produced under the former methods, as the penetration and setting of the binding medium within the pores and cavities of the normally weak aggregate imparts thereto the necessary strength and capacity to resist wear and disintegration under traffic conditions.

Moreover, the thorough impregnation or penetration of the binding medium into and below the surfaces of the aggregate elements, whether the latter be weak or strong, will have the further highly desirable effect of providing a reserve of active binding medium which is available for securely bonding or binding together the various parts of the aggregate elements should the latter actually break down or fracture under extraordinary traffic conditions. In other words, the impregnation of the aggregate provides sufficient bituminous cement to rebond any aggregate that might be accidentally fractured after the composition has been laid, which result could not possibly be effected by the former method of merely surface coating the aggregate. As a rule, the weaker the aggregate, the more porous it is, and consequently the greater the percentage of impregnation thereof with the bituminous binding medium, and it therefore follows that even should such a character of aggregate be actually reduced to fine particles under traffic con-

ditions, there would be sufficient impregnating binding medium to bond effectively the broken or disintegrated aggregate and unite the same into a firm, coherent element of the surface coating.

The apparatus illustrated has been found most effective in producing a highly efficient bituminous cement-aggregate mixture, irrespective of the character, size and condition of the aggregate employed, so that when the composition is applied to a road surface the latter will be found to possess the desirable qualities of resiliency, imperviousness to moisture, and durability under most trying traffic conditions, and will evidence no tendency to shove or roll under load or high temperature, and will not crack, disintegrate or slough off when subjected to extremely low temperatures.

In the drawings, which exemplify the preferred form of apparatus for carrying out the mixing of the composition, a generally cylindrical drum or barrel 1 made of sheet steel or the like has convex heads 2, 2, secured thereto, the receptacle being provided with an opening at one side of the cylindrical section surrounded by a neck portion 3, with which cooperates a door or closure 4 hinged at 5 to a supporting bracket 6, the door engaging a reinforcing rim 9 having a packing ring 10 imbedded therein. The door is retained in fluid-tight contact with the rim by means of a latch 7 engaging a keeper 11 pivotally attached to a bracket 12 secured to the wall of the neck 3, said latch carrying a set screw 8.

Secured centrally in the heads 2, 2, are thimbles 15 and 16, in which are rigidly secured shafts or journals 17 and 21 respectively, which are mounted in suitable bearings, not shown, upon which the receptacle rotates. Rotary motion is imparted to the receptacle by any suitable gearing such as a worm-wheel 18, fast on shaft 17, which meshes with a worm 19 on a cross-shaft 20, which receives power from any suitable source. The shaft or journal 21 is hollow to receive an inlet pipe for supplying the binding medium and also the air or other gaseous medium under pressure to the interior of the receptacle. The said shaft is provided with a suitable gland or stuffing box 22 at its outer end to prevent the escape of the gaseous pressure between the hollow shaft and the inlet pipe.

The inlet or supply pipe 24 is connected at its outer end by a suitable coupling with a pipe line 23, which in turn is in communication with the supply of heated bituminous binding material and with the supply of air under pressure, these elements being controlled by appropriate valve mechanism, as will be understood. The inner end of pipe 24 is connected by an elbow 25 with a vertical pipe 26, which constitutes one supporting element for a spray header extending longitudinally and transversely of the interior of the drum or receptacle and above the axis of rotation thereof, said header comprising longitudinal pipe sections 28 coupled together by unions 27 having discharge nozzles on their lower faces, and transverse pipe sections 29 coupled together by similar nozzled couplings 30. Preferably the ends of the transverse pipes 29 are also provided with elbow nozzles 31. The opposite end of the multiple section header is supported by a short rod section 32 engaging a coupling 27^1 in the corresponding header pipe 28, at its upper end, and a reducing nipple 33 at its lower end, which nipple is provided with a bearing ring or collar 34 mounted on the inner end of the shaft 17 and secured thereto by a suitable screw-bolt 35, so that said shaft may freely rotate without imparting movement to the collar 34 and the spray header supported thereby.

In order to lift and agitate the mineral aggregate and cause the latter to fall or cascade in the receptacle, one-half of the inner surface of the drum-like section 1 opposite the opening therein is provided with a series of angularly disposed blades 40 secured to the wall of the drum by brackets 41, the blades being preferably arranged in pairs disposed at approximately right angles to each other, and at approximate angles of 45 degrees to the axis of rotation of the receptacle.

In carrying out the invention, the aggregate of appropriate sizes and character is preferably heated to a temperature of from 300 to 350 degrees Fahrenheit, for the purpose of driving off the moisture, and, what is more important in this particular case, to cause the aggregate to expand and the pores thereof to open, and to rarify the air within the pores of the aggregate. The properly heated aggregate in appropriate quantity is then placed in the rotary drum or receptacle through the opening in the side thereof, and the cover 4 tightly closed. The receptacle is then rotated by means of the driving gear 18, 19, for a sufficient time to cause a thorough and uniform admixing of the various elements and sizes of the aggregate, after which the supply of bituminous binding medium, in accurately regulated quantity, is delivered from the pipe line 23, inlet pipe 24, and the spray header connected therewith. The binder, which is preferably heated to a slightly higher degree than the aggregate, is delivered

from the various nozzles 27 and 30 onto the body of the aggregate which is being tumbled and cascaded from the top toward the bottom of the receptacle by the action of the blades 40, said blades, because of their particular construction and arrangement, serving to lift the aggregate to fall or cascade in separated units toward the lower part of the receptacle, so that the individual elements of the aggregate will pass through the descending sprays of hot binding medium discharged by the stationary header. The continuous agitation and dropping or cascading of the aggregate, both before and during the application of the bituminous binder, will produce an intimate admixture of the various sized elements of the aggregate, and prevent the latter collecting in strata or layers graded according to size, which is one of the salient objections to the former modes of mixing aggregate and a binding medium. As the individual elements of the aggregate are repeatedly lifted and dropped through the sprays of hot bitumen, all the surfaces of each element of the aggregate are completely covered by the bitumen, as the tumbling and cascading of the mineral aggregate serve to separate effectively the various elements thereof, so that the entire surface of each element will be ultimately exposed to the bitumen sprays. When exactly the proper proportion of bituminous binder has been delivered to the receptacle to form a properly balanced batch of the composition, the supply of the binder is cut off and a supply of air or gas under pressure is admitted from pipe line 23, pipe 24, through the spray header, into the receptacle, the supply being continued until a gaseous pressure is produced within the receptacle sufficient to cause the binding medium covering the surface of the individual elements of the aggregate to be driven into the pores and openings of the aggregate, thereby effecting thorough penetration and impregnation of the aggregate elements well below the surfaces thereof, the impregnation being materially enhanced by the heated and expanded condition of the aggregate, which produces a partial vacuum within the bodies of the aggregate elements, and the pressure of the gaseous medium, which forces the bitumen into the aggregate, so that the impregnating portions of the binding medium extending into the bodies of the aggregate elements constitute a continuous series of key-like elements locking the superficial coating of bitumen to the individual aggregate elements; therefore, when the mixing operation is completed and the composition is applied to the road surface, all of the elements of the aggregate, which are uniformly distributed throughout the mass irrespective of the sizes of the elements, will be united into a coherent, compact, homogeneous mass with the various elements of the aggregate actually interlocked with the interposed and enveloping bitumen, and, through the binding action of the latter, with one another, so that the resultant composition is substantially uniform throughout in strength, wear resisting qualities, imperviousness to moisture and ability to withstand the varying changes of temperature due to the seasons, and the most exacting conditions of traffic.

After the given charge or batch of the mixture has been formed in the receptacle, as hereinbefore described, it is discharged by opening the door or closure 4, and the apparatus is ready to receive a new charge. As will be understood, the composite mixture discharged from the mixing apparatus is conveyed, while still in heated condition, to the place of application, where it is spread upon the roadway, worked down to grade and rolled, thereby producing a highly superior road surface.

While the composition has been described as particularly well adapted to the surfacing of roadways, pavements and the like, it will be understood that it will be understood that tions, but is equally effective in providing surface coating for floors, roofs, or other structures that are subject to stresses, traffic, loads, or varying conditions of weather and temperature which would require a stable, resistant, but more or less flexible and resilient covering.

In the event that the composition, after mixing, is to be shipped considerable distances, it will be found advantageous to carry out the process with a low penetration bituminous cement, which is brought to a high state of fluidity by means of a " cut-back ", or light oil, so that a complete coating and impregnation of the aggregate may be effected, and the composition may be shipped cold and even permitted to stand for a reasonable time without setting up, but when spread on the surface in a relatively thin layer, the volatile " cut-back " will be gradually dissipated, leaving the stable asphaltic cement to perform its normal function.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A method of preparing a bituminous

cement-aggregate composition which comprises first distributing the various sizes of aggregate uniformly throughout the mass by agitation and then applying a predetermined proportion of binding medium to the mass, while the latter is in an agitated condition, in the form of a uniform spray.

2. A method of preparing a bituminous cement-aggregate composition which comprises heating the aggregate to a degree sufficient to drive off the moisture and open the pores of the various sizes of the aggregate, agitating and tumbling the heated aggregate in a container, subjecting the agitated aggregate to a spray of hot bituminous binding medium, and finally subjecting the confined mass to gaseous pressure, whereby all the individual elements of the aggregate are impregnated and completely coated with the binding material.

3. A method according to Claim 1 or 2, in which the agitated and distributed mass of aggregate, while falling in a cascade, is subjected to a predetermined, regulated proportion of the binding medium.

4. Apparatus for carrying out the method above claimed, which comprises a rotary receptacle having angularly disposed blades provided on a portion of its interior wall, in which receptacle the aggregate is agitated, and tumbled to distribute uniformly its various sizes, the said blades being adapted to collect the aggregate and cause it to fall in a cascade in the centre portion of the receptacle, and a spray header disposed inside the receptacle and having a pipe connection through the axis of rotation thereof, so as to deliver a uniform spray of binding medium to the cascading and agitated aggregate, said header being adapted subsequently to admit gaseous pressure to the receptacle.

5. A bituminous cement-aggregate composition comprising an admixture of aggregate and bituminous binding medium, the individual elements of the aggregate being coated with the binding medium and the variously sized elements of the aggregate being uniformly distributed throughout the mass and united by the enveloping binding medium.

6. A composition according to Claim 5 in which all the uniformly distributed sizes of the aggregate are impregnated with the binding medium.

7. The improved bituminous cement-aggregate composition and method of making the same, substantially as hereinbefore described, for the purpose specified.

8. The improved apparatus for preparing a bituminous cement-aggregate composition, having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings, for the purpose specified.

9. Apparatus according to Claim 4, in which the spray header has a number of spaced spraying nozzles, covering a large area inside the receptacle.

Dated this 26th day of June, 1923.

For the Applicant,
HERBERT HADDAN & Co.,
Chartered Patent Agents,
31 and 32, Bedford Street, Strand,
London, W.C. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1924.